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Effects of different level of phosphatic fertilizers on soil health and yield of cowpea (*Vigna unguiculata* L.)

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Abstract
A field experiment was carried out during *kharif* season of 2021 to evaluate the "effect of different level of phosphatic fertiliser on soil health and yield of cowpea (*Vigna unguiculata* L.) in *inceptisol* soil. The experiment was laid down in 3x3 randomized block design having four levels of DAP 0, 25, 50, and 75% and also four levels of SSP0, 25, 50 and 75%respectively. The result showed that in treatment T_9 has maximum yield 1766.68 ha^{-1}regarding, gave the best results with respect to plant height 95.03 cm, number of branches $plant^{-1}$ 5.14, number of pod $plant^{-1}$ 18.35, length of pod (14.73), and seed straw (4105.33) and T_9 provides highest cost benefit ratio (1:2.13) and net profit (₹80547.65 ha^{-1}) in cowpea were to found best treatment combination.

Keywords: Cowpea, SSP, DAP, Economics and yield

Introduction
Cowpea (*Vigna unguiculata* L.) occupies a prominent position as its green pods form vegetable while; decorticated split grain (dal) is used for making delicious preparations (Aechra *et al*., 2017) [1]. Cowpea straw is considered a valuable fodder for milch cattle. A good crop of cowpea fully covers the ground "cover crop" and thus checks erosion and water loss from the field. Hence, it is of considerable importance in dry land farming (Ali *et al.*, 2015) [2]. Cowpea grain has high protein varying between 21.2% and 30.6% with an average of 24.6% and is also a rich source of calcium and iron (Anuja *et al.*, 2017) [3]. Cowpea is well adapted to poor fertility and low rainfall conditions. Cowpea grows best on fertile, loam soils with rainfall of 760 - 1520 mm during the growing period, and thrives best on dry areas. Amongst mineral nutrients, phosphorus is an essential nutrient after nitrogen (Bawa *et al.*, 2020) [8]. Indian soils are weak to moderate in accessible phosphorus (Khandelwal *et al.*, 2012) [12]. Phosphorus is a most important component for plants as it helps the healthy development of root system and also hastens the maturity (Keshwa *et al.*, 2012) [11]. Phosphorus is an essential nutrient both as a part of several key plant structure compounds and as a catalysis in the conversion of numerous key biochemical reactions in plants (Kumar *et al.*, 2014) [13]. Phosphorus is a vital component of ATP, the "energy unit" of plants. ATP forms during photosynthesis, has phosphorus in its structure, and processes from the beginning of seedling growth through to the formation of grain and maturity (Aryal *et al.*, 2021) [4]. PROM improves the physical, chemical and biological properties of the land and expands the crop production. (Babar *et al.*, 2011) [6]. It improves electrical conductivity of soil and enhances the activity of beneficial microorganisms in soil Phosphorous Rich Organic Manure (PROM) is an organic alternative and indigenous source of Phosphatic fertilizer (Ayodele *et al.*, 2014) [5]. This substance is more efficient source for adding phosphorous to soil as compared to chemical fertilizers like, DAP, MAP, SSP etc. (Balai *et al.*, 2017) [7] Besides, PROM also supplies the phosphorus to the succeeding crops as efficiently as it nourishes the crop to which it has been applied. DAP and SSP is a very good source of phosphate (P) and it is very much important compound in plant DNA and RNA (Magani *et al.*, 2019) [15].The other role of P in plant is seed production, crop maturity and root development. (Ilavarasi *et al.*, 2017)

Materials and Methods
During the kharif season 2021-2022, an experiment was done at the crop Research farm of the Soil Science and Agricultural Chemistry, Sam Higginbottom University of Agriculture, Technology and Sciences Prayagraj, Uttar Pradesh, which is located on the outskirts of

Prayagraj city. The area situated on the south of Prayagraj on right side of the river Yamuna on the south of Rewa road at distance of about 6 km from Prayagraj city. It is situated at 25°24'30" north latitude, 81°51'10" east longitude, and 98 meters above sea level. The location's highest temperature ranges from 46 to 48 ^{0}C, with lows of 40 to 50 ^{0}C. The relative humidity levels ranged from 20% to 94%. The average yearly rainfall in this area is roughly 1100 mm. Prayagraj has a sub-tropical and semi-arid climate, with rain falling primarily between July and September. The levels of DAP, @ 0%, 25%, 50% and 75%, and SSP@ 0%, 25%, 50% and 75%, respectively, were used to control the treatments. The soil was Sandy loam. The recommended fertilizer dosage Nitrogen 25 kg ha^{-1}, Phosphorus 50 kg ha^{-1}, Potassium 25 kg ha^{-1}, SSP 75 kg ha^{-1}, DAP 75 kg ha^{-1}, at 30, 60, and 90 days after seeding, the soil surface was scraped followed by weeding three times.

Results and Discussion

As depicted in table 2 shows that the maximum bulk density of soil (Mg m^{-3}), was found in T_1 (Control) which was 1.201 and minimum found in T_9 (50% SSP + 75% DAP) which was 1.185. This is show that the maximum particle density of soil (Mg m^{-3}), was found in T_9 (50% SSP + 75% DAP) which was 2.202 and minimum found in T_1 (Control) which was 2.186. The results shows that the maximum pore space (%) of soil, was found in T_1 (Control) which was 48.71 and minimum found in T_9 (50% SSP + 75% DAP) which was 45.51. The results shows that the maximum water holding capacity (%) of soil, was found in T_9 (50% SSP + 75% DAP) which was 45.620 and minimum found in T_1 (Control) which was 46.910. This shows that the maximum pH of soil, was found in T_1 (Control) which was 7.701 and minimum found in T_9 (50% SSP + 75% DAP) which was 7.202. The result shows that the electrical conductivity (dS m^{-1}) of soil was found in T_9 (50% SSP + 75% DAP) which was 0.201 and minimum found in T_1 (Control) which was 0.172. This is show that the maximum organic carbon of soil (%), was found in T_9 (50% SSP + 75% DAP) which was 0.483 and minimum found in T_1 (control) which was 0.414. The result shows that the maximum N of soil (kg ha^{-1}) was found in T_9 (50% SSP + 75% DAP) which were 189.39 kg ha^{-1} and minimum found in T_1 (Control) which was 149.65 kg ha^{-1}. The result shows that the maximum P of soil (kg ha^{-1}) was found in T_9 (50% SSP + 75% DAP) which were 39.36 kg ha^{-1} and minimum found in T_1 (Control) which was 23.62 kg ha^{-1}. The result shows that the maximum K of soil (kg ha^{-1}) was found in T_9 (50% SSP + 75% DAP) which were 226.23 kg ha^{-1} and minimum found in T_1 (Control) which was 218.52 kg ha^{-1}. The maximum plant height (cm) reported in T_9 (50% SSP + 75% DAP) 95.03 and minimum in T_1 (Control) 58.58 at harvest. The maximum number of branches plant^{-1}, number of pod plant^{-1} and length of pod in T_9 (50% SSP + 75% DAP) 5.14, 18.35, 14.73 and minimum in T_1 (Control) 2.38, 10.09, 6.64. This is shows that the maximum seed yield (q ha^{-1}) and straw yield was found in (50% SSP + 75% DAP) 1766.68, 4105.33 and minimum found in T_1 (Control) which was 575.64, 1147.37.

Table: 1 Physical – chemical properties

Particulars	Results
Physical properties	
Sand (%)	61.3
Silt (%)	24.6
Clay (%)	14.4
Texture Class	Sandy loam
Soil Colour	Dry soil-Pale Brown Wet soil-Olive brown
Bulk Density (Mg m^{-3})	1.201
Particle Density (Mg m^{-3})	2.186
Pore space (%)	45.71
Water Holding Capacity (%)	45.620
Chemical properties	
Soil pH	7.701
Electrical Conductivity (dS m^{-1})	0.172
Organic Carbon (%)	0.254
Available Nitrogen (kg ha^{-1})	149.65
Available Phosphorus (kg ha^{-1})	23.62
Available Potassium (kg ha^{-1})	195.52

Table 2: Effect of different level of phosphatic fertiliser on soil properties

Treatment	BD (Mg m^{-3})	PD (Mgm^{-3})	WHC (%)	P S (%)	pH (w/v)	EC (dS m^{-1})	OC (%)	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})
T_1	1.201	2.186	45.620	45.71	7.701	0.172	0.414	149.65	23.62	218.52
T_2	1.188	2.208	44.698	46.17	7.632	0.180	0.427	155.02	26.64	221.87
T_3	1.186	2.194	46.948	45.94	7.631	0.193	0.437	159.38	31.58	224.75
T_4	1.189	2.204	44.333	46.03	7.453	0.176	0.423	153.36	26.61	219.22
T_5	1.187	2.202	46.520	46.07	7.381	0.189	0.425	154.29	29.99	223.45
T_6	1.185	2.202	46.582	46.16	7.262	0.198	0.447	163.96	36.20	222.78
T_7	1.187	2.200	45.700	46.04	7.334	0.185	0.422	157.08	28.73	222.66
T_8	1.186	2.199	47.195	46.06	7.214	0.195	0.441	161.18	33.01	224.24
T_9	1.185	2.202	46.910	45.51	7.202	0.201	0.483	189.39	39.36	226.23
S.Em (±)	1.188	0.020	1.04	0.49	0.04	0.005	0.013	5.65	0.47	4.33
C.D.	0.000	0.059	3.11	1.46	0.13	0.01	0.038	16.93	1.40	4.99

Note: BD- Bulk Density, PD- Particle Density, WHC- Water Holding Capacity, PS- Pore Space, EC- Electrical Conductivity, OC- Organic Carbon, N-Nitrogen, P- Phosphorus, K- Potassium

Table 3: Effect of Different level of phosphatic fertilizer of morphological parameters and yield attributes of okra

Treatment	Plant height (cm)	No. of branches plant^{-1}	No. of pod plant^{-1}	Length of Pod (cm)	Seed yield (q ha^{-1})	Straw yield (q ha^{-1})
T_1	58.58	2.38	10.09	6.63	575.64	575.64
T_2	75.28	3.78	13.36	9.15	763.70	763.70
T_3	85.50	4.29	16.38	10.75	1017.03	1017.03
T_4	73.69	3.39	12.55	7.95	704.92	704.92
T_5	83.68	4.25	15.37	10.35	1002.60	1002.60
T_6	90.15	5.03	17.99	13.15	1497.35	1497.35
T_7	81.28	4.06	14.13	10.00	976.50	976.50
T_8	89.68	5.00	17.39	12.52	1369.67	1369.67
T_9	95.03	5.14	18.35	14.73	1766.68	1766.68
S.Em (±)	0.60	0.02	0.18	0.33	13.15	13.15
C.D.	1.80	0.07	0.55	0.98	39.42	39.42

Summary
The soil parameter such as Bulk density **(**Mg m^{-3}), Particle density **(**Mg m^{-3}), Porosity (%), Water holding capacity (%), Soil pH, Electrical conductivity (dS m^{-1}), Organic carbon (%), available Nitrogen (kg ha^{-1}), available Phosphorus (kg ha^{-1}), and available Potassium (kg ha^{-1}). The Growth and yield parameters were significantly influenced by application of different level of phosphatic fertilizer such as Plant height (cm)**,** Number of branches plant^{-1}**,** No. of pod plant^{-1}, length of pod, seed yield and straw yield. However maximum Plant height (cm) (18.39, 50.62 and 95.03at 30 DAS**,** at 60 DAS and at harvesting respectively)**,** number of branches per plant (5.14)**,** No. of pod per plant (18.35), length of pod (14.73), seed yield (1766.68 q ha^{-1}) and straw yield (4105.33).

Conclusion
It is concluded from the trail that Effects of Different Level of Phosphatic Fertilizers on Soil Health and Yield of Cowpea experiments, shows in that SSP with DAP can be used as a source of plant nutrients. Its application to soil along or combination brought an increase in the yield of cowpea and improved the soil organic carbon content, available N, P, K, physical properties (Bulk density, particle density and porosity) economically variable.

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